A Study on Prevalence of Hearing Loss as a Complication of Diabetes

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Abstract — The aim of this study is to assess the hearing loss prevalence in association with diabetes & correlate it with age and duration of diabetes. This study was done in outpatient and inpatient department of ENT & endocrinology department in PSG Institute of Medical Science and Research, Coimbatore, Tamilnadu, from July 2012 -2014. Evaluation of 200 patients with otoscopic examination of canal and tympanic membrane status, worked up with PTA .Audiogram was analyzed for hearing loss &classified by WHO criteria found that 72 % individuals with diabetes were noted to have mild SNHL ,20 % with moderate SNHL,3% moderate severe SNHL, 4 % severe ,1% with profound hearing loss .In our study we concluded that after analyzing audiogram of diabetic patient ,they are more prone to develop mild to moderate SNHL and duration of diabetes and gender were found to have no effect on incidence of hearing loss.

Index Terms — Diabetes, audiogram, sensorineural hearing loss.

I. INTRODUCTION

Hearing impairment is the most frequent sensory deficit in human populations, affecting more than 250 million people in the world. Diabetes Mellitus is a metabolic disorder, due to relative or absolute lack of insulin resulting in elevated blood glucose levels associated with long term vascular and neurological complications. Among glucose metabolism disorders, diabetes mellitus is the one most commonly related with auditory disorders. The complex arrangement of inner ear makes it potential target of hyperglycemic damage. Diabetic patients are more prone to complications of hyperglycemic, as all body cells are exposed to high levels of plasma glucose. The organ of corti cells are important structures for hearing mechanism and turn out to be the potential target for damage, due to high glycemic levels, micro vascular compromise, their complex structure and arrangement. Thus, screening of these patients at a high risk of developing sensory neural hearing loss, will aid in early diagnosis and management.

II. AIM OF THE STUDY

- To Study the prevalence of Hearing loss its association with Diabetes.
- To assess the hearing loss in diabetics and correlate it with age and duration of diabetes.

III. MATERIALS

This is a cross-sectional study in which evaluation of study population who were diagnosed with diabetes mellitus study method undergoing treatment on Out-Patient or In-Patient basis in department of ENT and Endocrinology. In PSG Institute of Medical Science & Research. Coimbatore, Tamilnadu from July 2012 to July 2014 were considered.

- History of every patient was taken in detail and importance was given on their presenting complaints. Any significant past history of ear discharge. Hearing loss or previous ear surgeries were elicited. History of duration of diabetes and mode of treatment were given importance.
- All the patients were taken up for Otoscopic examination, in which the ear canal and status of tympanic membrane were assessed.

Inclusion Criteria for cases considered in the study

- Known cases of Diabetes mellitus
- Age-group > 30 years to < 60 years
- Both genders

Exclusion Criteria for cases

- Individuals involved in occupations exposing to loud noise.
- Individuals with previous history of ear discharge/hearing loss/ tinnitus/ear surgery
- Otoscopic examination showing any ear pathology like wax, discharge, retracted tympanic membrane, perforated tympanic membrane or tympanosclerosis.
- Patients unwilling to comply with the study.

IV. METHODOLOGY

All 200 patients were worked up with a pure tone audiometry. The audiogram was analyzed for hearing loss and if present it will be classified according to WHO classification. Pure Tone Audiometry is a routine audiometric evaluation and the resulting pure tone audiogram is used as a basic description of the degree of hearing loss. Audiological examination was performed using a Pure Tone Audiometer model GS1 61, in a soundproof room in the ENT department, PSG Institute of Medical Sciences & research. Earphones were used to test hearing by air conduction and a small vibrator, which was placed over the mastoid was used to test hearing by bone conduction. All audiometers are incorporated with a calibration circuit, which allows the output sound level to be set at particular frequency. The signals presented to the subject by the audiometer were all characterized by its sound pressure level, frequency and wave form which were all delivered at

controlled rates.

The entire procedure and purpose of the test was explained in detail to the patients. Biological calibration of the system was done on daily basis before starting the procedure. Both air and bone conduction were tested for each ear.

V. RESULT

In this study, analysis of 200 patients diagnosed mellitus was done in the Department of E.N.T, PSG Institute of Medical Sciences& Research from July 2012 to July 2014 to determine the incidence of hearing loss as a complication of diabetes mellitus. Detailed evaluation of each case was done comprising of the history, clinical examination including otoscopic examination with otoscopic and pure tone audiometry. The clinical data was collected by means of a proforma and the observations from the audiogram were analyzed with the Master chart as shown in the Annexure. In our study of 200 diabetic patients, 110 (55%) cases out to have sensorineural hearing loss.

Fig.1. Age distribution of hearing loss.

Fig. 2. Gender distribution.

TABLE I: OVERALL DISTRIBUTION OF HEARING LOSS		
Hearing Loss	n	(%)
Bilateral – Normal hearing	90	45
Bilateral –hearing loss	95	47
Unilateral hearing loss		
Left	11	6
Right	4	2
Total	200	100

Fig. 3. Hearing loss in various Age groups.

Fig. 4. Duration of DM in study population.

Fig. 5. Gender vs Hearing loss.

TABLE II: DISTRIBUTION OF HEARING LOSS WITH DURATION OF DM

		Mean DM Duration of Hearing Loss					
				95% CI or Mean		Minimum	Maximum
	N	Mean	SD	Lower Bound	Upper Bound		
Normal	90	3	3	2	4	1	20
Bilateral SNHL	95	5	3	5	6	1	25
LT HL	11	5	4	3	7	2	15
RT HL	4	5	3	1	9	1	6
Total	200	4	3	4	5	1	25

Fig. 6. Degree of Hearing Loss.

VI. DISCUSSION

Hearing loss is important of hearing and its severity varies from mild to severe or profound and in general hearing loss may be conductive, sensorineural, or mixed. The typical hearing impairment described in diabetic patients is a bilateral sensorineural hearing loss. Diabetes mellitus has been implicated as independent causative factor of sensorineural hearing loss [14].

A. Age

Our study has evaluated the hearing loss in the patients with diabetes and the influence of hyperglycemia on hearing and it shows 55% incidence of deafness. And the peak age group being affected with hearing loss in our study was between 50-53 years of age.

In contrast a study conducted by Rajendran S. Anandhalakshmi et al [16] showed maximum incidence between 40-50 years of age. On further review, we realize that acquired on set sensorineural hearing loss can occur early in diabetic patients. Usually age-related sensorineural deafness is more common in people more than 60 years of age. But here it is seen that diabetic patients are higher risk of developing this sensory loss at a much younger age group.

It is also that in our study there were more people with diabetes among the age group 51-60 years of age (50%). The p value is 0.05, which makes it statistically significant.

B. Sex

In our study it was noted that a greater number of diabetic males were affected with hearing loss, than females. In contrast Taylor and Irwin (1978) observed that female patients with diabetes had significantly greater hearing loss when compared with male patients with diabetes.

But according to Cullen and Cinnamon [17], Male patients with diabetes had worse hearing than female patients with diabetes.

From our study, we conclude that sex of an individual is not statistically significant ($p > 0.05$) parameter in considering the males are more prone to develop Diabetes mellitus.

C. Overall incidence of hearing loss in diabetics

In our study, we evaluated the hearing loss in the patients and the influence of hyperglycemia on hearing and it shows a 55% incidence of deafness. Friedman et al [18] showed a 55% incidence of hearing loss in diabetic patients. Which is the same incidence found in our study.

Kakarlupudi et al [19] found that hearing loss was more common in diabetic patients (13.1%) than the control nondiabetic healthy subjects.

Wenget al [20] noted that among the 67 diabetic subjects examined, 44.8% of them had profound hearing loss. This is much lesser comparing to our study.

D. Duration of diabetes

In our study a greater number of patients with diabetes were found 3-5 years group, about 48%, followed by less than 2 years duration 31%.

Comparing with, the duration of diabetes and hearing loss, more patients in the group 3-5 years had hearing loss, around 49%, followed by less than 2 years, around 32 years. Whereas only 20% patients were found to have hearing loss in 5-10 years group.

In study it is seen that the duration of diabetes is not a significant criteria for developing sensorineural hearing loss. The p value is < 0.05 , making it statically significant.

A study by Celik et al [21] observed that as the duration of diabetes increased to 15 years, the incidence of hearing loss also increased. After 15 years of diabetes, the influence on hearing loss was not significant. This change was not observed in our study as cases in our study were all mostly found to be less than 15 years.

E. Overall severity of hearing in individual ear

It is noted that in the right ear 95 cases had normal hearing, 84 cases had mild hearing loss, 15 had moderate and 3 cases had moderately severe and severe hearing loss respectively.

It is noted that in the left ear, 92 cases had normal hearing, 81 had minimal hearing loss, 16 had moderate loss 8 moderately severe, 2 with severe and 1 with profound hearing loss. Thus, making it statically not significant ($p > 0.05$). The above data was calculated taking the gender as consideration and compared the hearing. But no significant changes were noted in severity of hearing.

Taking into consideration the duration of diabetes, it is noted that in right ear maximum of 58 (30%) cases had hearing loss among the group 3-5 years, among which 49 (25%) cases had mild hearing loss; 6 (3%) cases had moderate hearing loss and 3 cases (2%) had moderately severe loss, followed by 5-10 years group where 31 cases (16%) had hearing loss

And in left ear it is noted that , maximum of 59(30%) cases had hearing loss among the group 3-5 years, among which 44(22%) cases had mild hearing loss; 8 (4%) cases had moderate hearing loss and 5 cases (3%) had moderately severe loss, followed by 5-10 years group where 32 cases (17%) had hearing loss.

Thus, we conclude that predominantly mild sensorineural hearing loss in both ears. The p value is < 0.01 , making it statistically significant.

F. Overall severity of hearing loss

In our study, 72% of individuals with diabetes were noted to have mild sensorineural hearing loss, followed by 20% with moderate sensorineural hearing loss. Only 1% had profound hearing loss.

A study conducted by Rajendran et al showed a result similar to our study. The diabetic individuals showed significant high frequency, bilateral, mild to moderate sensorineural hearing loss (73.3%) as compared to controls of similar age.

Whereas Weng et al [14] observed that among the 67 diabetic subjects examined, 44.8% of them had profound hearing loss.

Many studies were conducted to observe the pathogenesis of this sensorineural loss observed in diabetics. During this course, many studies suggested that diabetes is a cause of hearing loss. The probable mechanisms suggested were microangiopathy in the inner ear, neuropathy of cochlear nerve, or even a combination of both. Outer hair cell dysfunction and disruption of endolymphatic potential were noted in some studies. Some of the tissue effects of diabetes are considered to be related to the polyol pathway, in which glucose is reduced to sorbitol.

Generally, the accumulation of Sorbitol is implicated in neuropathy as it causes a decrease in myo inositol content and further leads to decrease in Na⁺K⁺ATPase activity [22].

Makishima and Tanaka [23] observed that there was severe atrophy of the spiral ganglion in the basal lamina and the middle turns of cochlea in diabetic individuals with sensorineural hearing loss. It was also observed that 8th nerve revealed changes in the myelin sheath, which showed degeneration and fibrosis of perineurium

Jorgensen [24] in his study noted thickening in the walls of the vasa nervorum in the 8th nerve which lead to the development of acoustic neuropathy.

In the study by Wackym and Linthicum [25] noted small microangiopathic changes in the regions of endolymphatic sac, the stria vascularis and basilar membrane.

Van den Ouweland et al [26] observed mutational changes in the mitochondrial RNA. It was also observed that in a small subset of patients, with maternally inherited diabetes showed some degree of sensorineural hearing loss.

Lisowska et al [27] in their study noted that in diabetic patients, there was abnormality in the function of hair cells in auditory brain stem responses.

Fukushima et al [28] concluded that Type 2 Diabetes lead to changes in cochlea, like significant atrophy of stria vascularis and basal turn, which was the likelihood of hearing loss in their patients.

In our study, we conclude that after analyzing the audiograms of the diabetic patients, it is noted that they are more prone to develop mild to moderate sensorineural hearing loss. The duration of diabetes as well as sex of the individual were found to have no effect on the incidence of hearing loss.

REFERENCES

- [1] Dhingra P.L. Diseases of Ear, Nose and Throat, Elsevier edition, 2009.
- [2] Colin Mathers1, Andrew Smith2, Marisol Concha3; Global burden of hearing loss in the year 2000.
- [3] World Health Organization. World Health Report 2001. Mental health; New Understanding, New Hope, Geneva, World Health Organization 2001.
- [4] WHO Study Group. Diabetes mellitus. Technical Report Series 727. Geneva; World Health Organization, 1985.
- [5] Savage PJ, Bennion LJ, Bennett PH. Normalization of insulin and glucagon secretion in ktosis-resistant diabetes mellitus with prolonged diet therapy. *J Clin Endocrinol Metab* 1979;49:830 (1)-833.
- [6] Agner T, Damm p, Binder C. Remission in IDDM; prospective study of basal C-peptide and insulin dose in 268 consecutive patients. *Diabetes Care* 1987.
- [7] Gauguier JR III, Alberti KGMM, Davidson MB, et al. Report of the Expert Committee on the Diagnosis Mellitus Diabetes care 1997;20:1183-1197.
- [8] Tanks S, Kobayashi T, Momostu T. A novel subtype 1 diabetes mellitus. *NEng J Med* 2000;342:1835-1837.
- [9] 9) Tuner Re. Cull CA, Frighi V, et al. Glycemic control with diet, suphonyl urea, Metformin, or insulin in patients with type 2 DM; Progressive requirement for multiple therapies. UK Prospective diabetes study group. *JAMA* 1999;281:2005-2012.
- [10] King H, Rewers M. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. *Diabetes care* 1993;16:617-621.
- [11] Boyko EJ, de courten M, Zimmet PZ, et al, Features of the metabolic syndrome predict higher risk of the diabetes and impresseded glucose tolerance; a prospective study in Mauritius, *Diabet Med* 2003;20:915-920.
- [12] Gareth Williams John C. Pickup. Text book of diabetes mellitus. Blackwell publishing Ltd, Oxford, Third edition, 2003.
- [13] Fukushima H, Cureoglu S, Schachern PA, Paparella MM, Harada T, Oktay MF, Effects of type 2 diabetes mellitus on cochlear structure in humans, *Arch Otolaryngol Head Neck Surg*.2006;132(9):934-8.
- [14] Maia CA, Campos Ca Diabetes mellitus as etiological factor of hearing loss. *Rev Bras Otorrinolaringol*. 2005;71:208-214.
- [15] Taylor, I.G, Irwin, J. Some audiological aspects of diabetes mellitus, *J. Laryngol Otol*.1978;92:99-113.
- [16] Rajendran s, Anandhalakshmi, Mythili B, ViswanTHA Rao Evaluation of the Incidence of Sensorineural hearing loss in Patients with Type 2 Diabetes Millitus, *Int J Biol Med Res*.2011;2(4); 982-987.
- [17] Cullen JR, Cinnamon MJ. Hearing loss in diabetes. *Int J Laryngol Otol*.1993;107(3):179-82.
- [18] Friedman SA, Schulman RH, Weiss S. Hearing and diabetic neuropathy, *Arch Intern Med*. 1975;135(4):573-6.
- [19] KAKarlapudii V, Sawyer R, Staeker H. The effect of diabetes on sensorineural hearing loss *Otol Neurotol*. 200;24(3); 382-6.
- [20] Weng SF, Chan YS, Hus CJ, Tseng FY, Clinical features of sudden sensorineural hearing loss in diabetic patients *Laryngoscope* 2005;115(9); 1676-80.
- [21] Celik O, Yalcin S, Celebi H, Ozturk A, Hearing loss in insulin dependent diabetes mellitus. *Auris Nasus Larynx* 1996;23;127-32.
- [22] Dennis Kasper, Anthony S, Fauci, Dan L. Longo, Eugene Braunwald, Stephen L. Hauser, J. Larry Jameson and Joseph Loscalzo, Harrison's Principles of Internal Medicine, McGraw-Hill Companies Inc. United States of America 17 th Ed.2008.
- [23] Makashima, K., Tanaka, K. Pathological changes of the inner ear and central auditory pathways in diabetics. *Ann Otol Rhinol Laryngol*.1971;80:218-288.
- [24] Jorgensen, M.B>. The inner ear in diabetes mellitus. *Arch Otolaryngol Head Neck Surg*;1961;74:31-39.
- [25] Wackym. P.A. Linthicum F.H. (1986) Diabetes mellitus and hearing loss, Clinical and histopathologic relationship. *Am. J. Otolaryngol*. 1986;7:176-1823.
- [26] Van den Ouweland JM, Lemakes HH, Gerbitz KD, maassen JA, Maternally inherited diabetes and deafness (MIDD); A distinct subtype of diabetes associated with a mitochondrial t RNA^{Leu} (urr) gene point mutation. *Muscle Nerve*. 1995;3:s124-30.
- [27] Lisowska G, Namyslowski G, Morawski K, Strojek K. Otoacoustic emissions and auditory brain stem responses in insulin dependent diabetic patients. *Otolaryngol Pol*.2002;56(2);217-25.
- [28] Fukushima H, Cureoglu S, Schachern PA, Paparella MM, Harada T, Oktay MF. Effects of type 2 diabetes mellitus on cocochlear structure in humans, *Arch Otolaryngol Had Neck Surg*. 2006; 132(9).

- [29] Fangchao Ma, Orlando Gomez – Marin., David J.Lee, Thomas Balkany . Diabetes and hearing impairment in Mexican American adults; a population – head study, *J.Laryngol Otol.* 1998;112’835-839.
- [30] Gibbin KP, Davis CG, A hearing survey in diabetes mellitus *ClinOtolaryngol Allied Sei.* 1981;6(5);345-50.
- [31] Austin DF, Konrad- Martin D, Griest S, Memillan GP, McDermott D, Fausti S. Diabetes related changes in hearing. *Laryngoscope.*2009;119(9);1788-96.
- [32] Sakuta H, Suzuki T. Yasuda H, Ito T.Type 2 Diabetes and hearing loss in personnel of the Self-Defense Forces. *Diabetes Res Clin Pract*, 2007;75(2); 229-34.